instance, a matter of difficulty and delicacy; but as so much is at stake, these considerations must necessarily give way to a correct appreciation of the danger which would ensue from neglecting an examination, when the discharge from the vagina was so offensive as to suggest the possibility of gangrene and subsequent adhesive inflammation.

It may not be useless to call attention to the great resistance, and in two of the cases entire want of fluctuation, which existed in the distended sac formed by the uterus and vagina, as felt through the rectum, and which might lead the surgeon to doubt the accuracy of his diagnosis, did not other marks assist in forming it.

BOSTON, *Feb.*, 1851.

ART. II.—*Tissue, and its Retrograde Metamorphosis.*—By W. J. BURNETT, M. D., of Boston, Mass.

IF we commence at the first appearance of an individual organization, the ovum, we shall find that in its primitive condition, when examined by the microscope, it will appear to be composed of granules, and when examined chemically, that these same granules are only oil and albumen combined. These so-called granules are not properly such, for they are not solid particles, but utricles, or little albuminous sacs filled with oil.

From these primordial utricles are developed the vitelline cells, and the germinative vesicle and its contents, which, after being vitalized by impregnation, undergo a series of metamorphotic changes, ending in the production of the individual being, with its various tissues.

Two facts are here to be recognized; first, that oil and albumen, thus vitally combined, form the basis of all animal tissues; and, second, that these utricles are the parents as it were of all organized forms. Moreover, they constitute the first material expression of the union of formative power with matter; and, although identical as to their physical characteristics, according to the best microscopic evidence, yet they contain those heterogeneous forces which have their complete expression in the many and different tissues in which their existence is lost and ends.

Those utricles, for instance, which end in the formation of muscle, and cannot, as such, be distinguished from those producing glandular or any other tissue, each preserve faithfully to the end their distinctions, embodying in their minute forms the ideas, as it were, of the future form and conditions of life.

Reverting then to our simplest idea of tissue, it is this elementary form, an utricle, vitalized albumen combined with animal oil.

Now, in the elimination of tissue in its compound form, that is, capable of a function, these utricles serve either a direct or an indirect agency. They enter directly into and form the lower fibrillated tissues, or they serve as a kind of basement for some of the higher. Then, again, indirectly, they pass on to their highest condition of cells, which form the groundwork of all tissue, exercising true function.*

Recent, and some of the best microscopical studies in histogeny, show thus the value of these primitive forms, and also that, if we except the secerning processes, there are no powers possessed by adult cells which are not equally possessed by these utricles. In the nutrition of tissue, after it has been formed, as well as in its reproduction, when forming, they still preserve their important agency; for, in the effused plasma of the blood, their number is expressive of the nutritive power, and they form, moreover, the cytoblastematous material of all the cells evolved in the process.

I have thus imperfectly sketched the relations of these elementary forms to tissue, and its formation, as preliminary to the consideration, and for the better elucidation of another process of tissue of a quite dissimilar character.

This is the retrocession of an adult tissue back to its elementary condition, a change which perhaps may be well expressed by the terms *retrograde metamorphosis.*

When a compound tissue has attained its perfect condition—and its function, beyond this (if it has any) is not required, and therefore its nutrition is nearly suspended—there is with it a constant tendency to fall back to its basement composition, and where it is complicated in structure, the different phases of its growth are there seen in an inverse manner. There being no proper death of the part, there is a disintegration, an unfolding, without a decomposition. It is a result, also, which must be carefully distinguished from real atrophy—for in this last the structure is not destroyed, but only the liquids diminished, and a simple change of nutrition in excess, being sufficient to obtain its original power and fulness, which is not the case in tissues whose structure is lost by a retrograde metamorphosis, in which, I scarcely need add, the result is either a granular, blastema-like product, or its near approach.

Now, in every well-formed normal tissue there is a power resident, which we may call a continuation of the germ power, or we may consider it as one of the characteristics of organized matter, but which, at any rate, finds its expression in the repetition constantly of that tissue, whatever it may be, or however situated. Where an injury is sustained, or a part lost, it is from the agency of this power that an attempt is made to replace the lost portion, which, in fact, is perfectly successful in the lower forms of life, only where the germ power is abundant, and where it is almost impossible to produce a nutrition, which differs from the normal type. On the other hand, with animals occupying a higher position in the scale, the nutrition of tissue seems to exist under a more complicated condition; the germ power is in its *minimum*, and where a part is lost, it is rarely replaced exactly.

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* See a paper "On utricles as the primordial forms of all animal tissues."—*Transact. Amer. Assoc. for the advancement of Science*, Aug. 1850.

In retrograde metamorphosis this power seems to have died out, and there is not even a feeble attempt to keep up the integrity of the tissue; yet a kind of nutrition exists, the vitality is maintained and decomposition prevented. And, exactly as with animals, when a true species is elevated by cultivation above its natural characteristics, these last may enter into its constitution and exist in its germ power, so that they can be perpetuated by hereditary transmission to quite an extent; yet where this power of cultivation ceases, the animal invariably reverts to its normal type. So in retrograde metamorphosis, when the germ power which has urged on these primitive particles to their different ends ceases, there is a tendency for all to recede to their basement, embryonic condition. Of course this process never occurs in a normal condition of tissue, and rarely in the higher compound tissues even in disease, except in the decline of life.

Its relation with disease and diseased products particularly deserve our attention, as here it has a practical as well as a physiological import.

We will first look to the adventitious products; tissues far beneath the normal type and where, therefore, it is best expressed.

With *pus*, for instance—the highest attainable product of inflammation, and which is a corpuscle with several granules—when it has reached this stage, it can pass no farther; and being a non-organizable form—if not there excreted or if pent up in a cavity, it immediately recedes to that granular, utricular condition which marked its formation. And here let me add, that whatever may be argued as to the difference of nature between the cell proper and its nucleus or nuclei—based upon an apparent difference of the effect acids may have upon each—it is pretty certain that when these distinctions are scarcely or not at all evident, their differences, if they did exist, are reconciled by the metamorphosis. The chemical analysis of pus, and especially when from an abscess unconnected with mucous membranes, as given by Von Bibra,* show that water, extractive matter, fat and albumen form almost the entire residue.

In carcinoma these changes are still more apparent, for they are marked by a quite active abnormal nutrition. In encephaloid of the breast, for instance, it is well known to those who are accustomed to such microscopic examinations how rich in cells it is when in progress, and that after having reached its adult age, it undergoes what is called a "fatty degeneration," that is, great quantities of fat are found in both a free and combined condition, while the cells have in a corresponding manner decreased, in other words have undergone that retrograde metamorphosis; a result equally borne out by chemical analysis. After this has taken place the watery portion is disengaged, and may there be absorbed, giving rise to those caverns of various sizes, lined with fat and albumen, which are so common in large and old cancers of the breast. In these instances the abundance of the granules shows the richness of this material, and the existence of free uncombined fat shows its excess over the albumen.

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* Quoted in Simon's Chemistry of Man, vol. ii. p. 91.

Retrograde metamorphosis here constitutes an attempt towards the cure, or a removal of the adventitious matter; for it is comparatively harmless when it has lost its corpuscular condition, and it is thus also prepared for its absorption, as testified by the caverns we find, and which, undoubtedly, might be complete, did the neighbouring vessels preserve their normal power.

In that other important morbid product, tubercle, the retrograde metamorphosis is but another name for its softening, and equally marks its adult age and decay of life; originally composed always of corpuscles, which, whether they be degraded exudation cells or corpuscles *sui generis*, is not by any means a material point in pathology, for we can get no nearer to their real nature. Their short and imperfect life is signified by their rapid tendency to this change, ending in a granular mass, enclosing a few rude rough corpuscles, that have withstood the process.

Here, as in the same with carcinoma, this forms the curative movement. Reduced to water, oil, and albumen, the first being absorbed, the last two are left in such a condition that, if shut off from external influence, they may either remain harmless a long time, or are liable to be hesitatingly taken up by the general nutritive process, a radical cure being then effected; there being no reason why tuberculous matter thus reduced should not be absorbed any more than there is of the common effused granular matter of inflammation. And here I may say that the most trustworthy pathological inquirers show the same result, tuberculous matter entirely disappearing, yet leaving behind it unmistakeable footprints of its former existence.

Now with this change, thus occurring in the three most prominent morbid products of the economy, unless we regard it as a real metamorphosis of material, it is quite difficult to account for the results produced; for we have a cellular tissue, the cells with their involucral albuminous membrane, all reduced to the condition of minute particles, which are not irregular, as from a pulverization of an inorganic body, but are real utricles.

When this change occurs with the higher tissues of a compound and more perfect organization, it is to a much less extent, because their conditions of growth are different, and their union on a higher and more permanent form of existence much stronger, for it involves a definite and fixed function.

But, although thus feebly expressed, it has at least an equal interest in pathology since it exists, with important tissues; and, in the most prominent cases, infringes directly upon the performance of some of the higher functions of life.

The muscular is pre-eminently one of the higher tissues in which it occurs, and to this we will first direct the attention. The muscular tissue is very complicated, quite as much so, perhaps, as any in the body; when therefore it undergoes the retrograde metamorphosis, the changes are more chronic, and the result less uniform than with simple cellular structures. But, before instancing this, it may be proper that the mode of its formation should be briefly alluded to. Although muscular structure has long been made out, with a tolerable uniformity of result, among microscopists, yet much obscurity has always existed as to its mode of formation; and this has been rendered all the more obscure by attempts to deduce the formula of its primitive growth, by picking apart its adult structure. However, from the carefully made observations of Valentine* and Reichert,† tolerable notions were entertained, but which were very far from being satisfactory to all.

To Lebert,‡ of a later day, belongs the credit of affording us definite and well-grounded opinions on this subject; which, as it now appears, is placed in as clear a view as any other point in histogeny. It is briefly as follows: In those parts where muscle is to be developed, large cells first appear; these become elongated, and arrange themselves in a linear seris, thus forming tubes, which constitute the first appearance of muscular *fibres.* These tubes are filled with granules; and the completion of the formation is occupied by the arrangement, in these fibre-tubes, of those granules in a regular manner, giving rise to what are called *primitive fibrillæ,* by microscopical anatomists.

Although I have not followed in the footsteps of Lebert to satisfy my mind practically of the correctness of these results, yet they appear to me to be true from what I have seen of the retrograde metamorphosis of this tissue, for there the gradual unfolding of the structure gives an opportunity to get glimpses of its early growth and formation. As might be supposed, this change is here the inverse of the formative process. First, the granules lose their regular arrangement, and run together, the striated character fading away; then the fibre cells at their points of junction become visible, and you perceive a jointed tube, the contents of which is a granular, oleo-albuminous mass.

This constitutes one of the forms of what is called by pathologists "fatty degeneration of muscle." It may occur under different general relations, which may here be well noticed. These are, first, where it infringes directly upon the life of the individual; and, second, where it exercises of itself no particular detriment. The first is when it is found in the heart; the second when met with in the muscles of the extremities. The last will be noticed first.

I have had the good fortune to meet with several instances in this category, each permitting a careful microscopic examination of the parts. In all these (six, I think) the cause could be traced either to a total disuse of the part, or to a previously existing inflammation, leaving the tissue with a poor and imperfect nutrition, or, lastly, to a starvation of the part from local arterial obstruction.

The following notes of a case taken from my memorandum book will perhaps sufficiently show the conditions of this change as occurring in the muscular system generally, and after an inflammatory process.

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* Muller's Archiv. 1840. p. 198. † Entwickelungsleben, p. 241.

‡ Annal. des Sc. Nat. 1849.

April 1850. Patient was of middle age. Two years since, he perceived, without known cause, a simple enlargement or "bunch" about the left elbow-joint. It came on without noticeable pain, and continued as a simple tumour for several months. The symptoms of a more acute inflammation appeared; it opened and discharged "scrofulous pus," then closed, then opened again, and so on, like an ordinary scrofulous abscess; leaving ultimately a considerably hard and unyielding tumour just below the joint. The arm was amputated; and a subsequent examination of the tumour exhibited the following appearances. An incised surface showed it to consist of a pale, reddish, fleshy mass, in which were interspersed white bands, these last, in some places, being the entire structure.

Under the microscope, the tough white portions were found to be made up of strong fibres running in the direction of the former muscular fibres; these contained broken nuclei, the remnants of their former cell structure, also quite a quantity of fat in the shape of granules and globules. The pale red portions presented a somewhat different aspect. Floating in the field of the microscope were cylindrical-shaped bodies, the transverse diameter of which was that of normal muscular fibre, and their length was about twice their width. They appeared to be not ragged bits but parts of a perfect whole. The usual muscular striæ were faintly seen in some of them, and occasionally there was perceived a long-jointed fibre evidently made up of these peculiar bodies. Much fat in the form of granules or utricles everywhere was present; in fact, what was not fibre was fat.

To sum up the whole, there was muscular tissue, from a previous damage done to its nutrition, from inflammation, retrograding to its primitive cell-type of structure, the latter becoming more and more apparent as the process took place.*

But this change occurring in the muscular tissue of the heart, has a corresponding import, as the life of the individual is compromised. It has received much attention of late, and especially since the microscope has demonstrated the true nature of the change. It constitutes one form of what is called by authors fatty degeneration of this organ. Rokitansky† was the first, as I am aware, to signify this change, and to distinguish it from others. It is a result which must be separated from that of mere fatty accumulation on and about the organ and between its fibres, which, like the same accumulation on and in the kidneys, being only an expression of general obesity, seldom gives rise to serious results. In this last also the fat exists in the shape of fat-cells, the origin of which can be traced to the surface, for the fatty infiltration (not degeneration) extends from without inwards.

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* Some time after, upon comparing the sketch I made at the time of the microscopical appearances with the figures of muscle developments given by Lebert, I was struck with their similarity.

† Handbuch der pathologisben Anatomie, Band. i. p. 287.

When, on the other hand, these real metamorphotic changes occur, they are traceable, as far as I am aware, to some serious perversion or suspension of the nutrition of the organ, and ossification or a partial obstruction of the coronary arteries is often a concomitant.

The mode of change is here the same as that of other muscles, as we have just described: the striated structure partially disappears, and the fibre appears filled with oleo-albuminous particles, and often considerable free fat; the tonicity of the tissue is lost, and, where these changes are extensive, there occur many sequelæ, the least of which is a feebleness of the heart's action; sudden rupture and death being the most serious. It is enough for me here thus to allude to this change when occurring in this organ; for it has sufficient importance and interest for an article by itself. It is one of those many instances in pathological anatomy, which I am happy to say are constantly increasing, in which the microscope has been of such eminent service, for the nature of this fatty condition of the organ could not be known without it, as it belongs, let me again say, to a quite different class of pathological changes from that of simple fatty accumulation.*

Constant practice in microscopical pathology is all the while convincing me of the frequency of this change in tissues, and that it may serve as the basis of many accidents in medicine. In closing this imperfect sketch of its history, I will speak briefly of it as taking place in other parts, where, although not the less equivocal, it has not been quite as much studied by the microscope.

Changes, referable I think to this process, may be observed in the muscular tissue of the small blood vessels of the brain, leading to what is called their fatty degeneration. This is of importance as bearing upon the subject of apoplexy. Mr. Paget† is the first that I am aware to bring the microscope to bear upon it. He has regarded the change as a "fatty degeneration," and I know too well his accuracy in microscopy to doubt its being so, did not his own language imply that it really comes under the same head as what I have been describing as a retrograde metamorphosis. He says: "When the fatty degeneration has made much progress, changes in the structure, and not rarely changes in the shape also of the affected blood-vessels, may be observed. The chief change of structure appears to consist in a gradual wasting of the more developed proper structures of the vessels." "They waste and totally disappear."

Mr. Paget describes carefully the appearance of the oil globules as they gradually and apparently invade the structure; he mentions also the appearance of many granules, which without doubt are the oil particles invested with albumen; all traceable, as far as my own observation goes, to an impaired nutrition of the vessels, their loss of vitality, and their corresponding receding metamorphosis. In all these cases the fault is with the *vasa vasorum*, their function being feebly performed.

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* The reader is referred to a very interesting article on fatty disease of the heart, in the last number of the *Medico-Chirurgical Transact.*, by Dr. Quain. When recently in London, I had the pleasure of seeing in Dr. Q.'s office many of the specimens which are the basis of the above referred to article.

† London Med. Gaz., Feb. 1850, p. 229.

In blood-vessels of other parts of the body, these same changes occur, and are of not the less pathological import, but space will not allow me to advert to them now.

Within a few years, and since the microscope has been made to bear upon most points of primitive pathology, the presence of fat, either in a free or combined form, in the different organs, has excited much attention, and especially in those cases where it does not, as far as we now know, exist in the normal state. Such, for instance, is the presence of fat in diseased kidneys, rendered all the more prominent by serving as the basis of a theory as to the nature of Bright's disease. Such was the view put forth in 1845 by Dr. Geo. Johnson,* and which he has sought to establish by a series of papers since published.

I cannot here enter into the details upon this point which it deserves, but I hope before long to put together my microscopical data on this subject. It is sufficient now for me to remark that I cannot agree with Dr. Johnson that Bright's disease is simply a fatty degeneration of the kidney; but the microscopical appearances I have sometimes observed I have thought traceable to this same retrograde metamorphosis existing in an imperfect degree, fat and granules being the result. Bright's disease, I may here remark, appears to me to be always, primitively, an acute or a subacute nephritis, and the conditions in which the primary attack may leave the organ are as various as the post-mortem appearances found on dissection. Except in children and young persons,† the nutrition rarely or never gets back to its normal type, but exists in an imperfect state; and from this bad nourishment, the retrograde metamorphosis sometimes occurs, the normal structure then disappearing partially, leaving in its place a low fibrillated tissue, and many oleo-albuminous particles.

The appearance of an unusual amount of fat may, in some cases, I think, be due to this cause, for it may be both in and out of the epithelial cells. I can here only thus speak of this subject, leaving until a future time its many important relations.

In conclusion, let me notice this change as occurring in one more tissue, the brain. Ramollissement or softening of this organ is now tolerably well understood, and recent studies in this direction cannot fail to make it more so.‡

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* "On the Pathology of Bright's Disease," Med.-Chir. Trans., vol. xxix.; also "On Inflammatory Diseases of the Kidney," vol. xii., new series.

† For cases of nephritis with concomitant albuminuria, yet passing away entirely, see "The Pathology of the Kidney in Scarlatina," by James Miller, M.D. London, 1850.

‡ See the investigations of *Dr. J. H. Bennett*, in the Edinb. Med. and Surg. Journal, vols. 58, 59, and 60. Also those of *Hasse* in Henle and Pfeufer's Zeitschrift. B. iv, p. 1; and those of *Kolliker*, in his Zeitschrift für Wissensch. Zoologie, B. i. p. 264.

This loss of structure occurs under two conditions; the first with and the second without the previous symptoms, or the subsequent appearances of inflammation—the first with an excess, the second with a deficiency of nutrition—for where softening exists without inflammation, there exists concomitantly an obstruction of the minute arteries of the brain; in other words, the tissue losing its power of tissue repetition, from deficient nourishment, gradually recedes to its primitive condition, and this, generally, so quietly that there are no mild to precede those more severe symptoms that ultimately await the patient.

There is much to be studied on this subject, and in these happier days of microscopical pathology it cannot be long before new data will be brought out.

All questions in pathological anatomy are of daily increasing interest, from their constant elucidation from microscopical studies; particularly is this true of the present one, forming these hastily written remarks; and, should what has been said induce others to pursue this same train of inquiry, they will find a wide range open before them, which may be carefully passed over with increasing delight and profit.

BOSTON, *February*, 1851.

ART. III.—*Bernard's Recent Discoveries in Physiology.* Reported by F. DONALDSON, M. D., Baltimore, Md.

HAVING a few months since witnessed some interesting experiments by M. Bernard, confirming the results of his late important researches in physiology, and not being aware of any notice of them having as yet appeared in our medical journals, we propose giving some account of them to the profession in this country. We are convinced alike of their accuracy and of the important light they are calculated to throw upon some heretofore obscure points in medical science. Indeed, M. B. has not as yet published some of the discoveries to which we shall call attention, and the only mention we have seen of them in print was some notes given in the "*Union Médicale*" of September last.

The first point of which we wish to speak is the discovery of the existence of a communication between the portal vein, the ascending cava and the kidneys, by means of which the urine is secreted from blood which has not as yet passed through the general circulation. It is called by its discoverer the *hepatico-renal circulation.*

Authors had frequently mentioned the rapidity with which substances taken into the stomach could be detected in the urinary secretion, and we have often